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**A Chemist Tests Samples of Bread** made from flour from different strains (varieties) of wheat. Seeds from the strains that produce high-quality bread are distributed to farmers for planting.

The term *specialty flours* is used for types of flour other than white wheat flour. They include rye flour, whole-wheat flour, and *mixes*. Mixes consist of flour and other ingredients used to make various foods, such as cakes and pancakes.

**How White Flour Is Milled.** Wheat kernels form the raw material for flour. They consist of a tough covering called the *bran*, a mellow inner part called the *endosperm*, and a tiny new wheat plant called the *germ*. To make white flour, millers separate the endosperm from the bran and germ and grind the endosperm into flour.

Various cleaning machines first remove dirt, straw, and other impurities from the grain. Next, the wheat is *tempered* (moistened). The moisture makes the endosperm more mellow and the bran tougher.

The tempered wheat passes between a series of rough steel rollers that crush the endosperm into chunks. Pieces of bran and germ cling to the chunks of endosperm or form separate flakes. Then the crushed grain is sifted. The tiniest bits of endosperm, which have become flour, pass through the sifter into a bin. Larger particles collect in the sifter. Next, these larger particles are put into a machine called a *purifier*. There, currents of air blow flakes of bran away from the endosperm particles. The endosperm particles are then repeatedly ground between smooth rollers, sifted, and purified until they form flour. In most mills, about 72 per cent of the wheat eventually becomes flour. The rest is sold chiefly as livestock feed.

Newly milled flour is cream-colored, but some mills

bleach it to make it white. They may also add chemicals that strengthen the gluten. Some chemicals both bleach the flour and strengthen the gluten. Such treatments must be carefully controlled because the addition of too much of a chemical ruins the flour.

Wheat is rich in starch, protein, B vitamins, and such minerals as iron and phosphorus. But the vitamins and some of the minerals are chiefly in the bran and germ, which milling removes from white flour. Most millers in the United States and many other countries enrich their product by adding iron and vitamins to white flour made for home use. Most U.S. bakeries use enriched flour, or they add vitamins and minerals to dough made with unenriched white flour.

The enriching of white flour has probably helped millions of people avoid malnutrition. Diseases caused by a lack of B vitamins were common in the United States before 1941. That year, the nation's bakers and millers began enriching white-flour products. Today, few Americans suffer those diseases.

**History.** People probably began to make crude flour between 15,000 B.C. and 9000 B.C. They used rocks to crush wild grain on other rocks. After farming began about 8000 B.C., people made flour from such cultivated grains as barley, millet, rice, rye, and wheat.

By the 1000's B.C., millers ground grain between two large, flat millstones. Later, domestic animals or groups of slaves rotated the top stone to crush the grain. By the A.D. 600's, windmills were powering flour mills in northern Europe.

Few further advances in milling occurred until 1780. That year, in England, a Scottish engineer named James Watt built the first steam-powered flour mill. In 1802, Oliver Evans, a Philadelphia miller, opened the first such mill in the United States. During the late 1800's, metal rollers replaced millstones in many American and European mills. Edmund La Croix and other millers in Minneapolis, Minn., perfected the purifier in the 1870's. By the early 1900's, automation had made flour mills more productive than ever.

Today, the United States has more than 250 flour mills. They produce about 12 million short tons (10.9 million metric tons) of wheat flour annually. The top flour milling centers in the United States, in order of production, are Buffalo, N.Y.; Minneapolis, Minn.; and Kansas City, Mo. Canada has about 50 flour mills, and they produce about 2 million short tons (1.8 million metric tons) of wheat flour yearly. Montreal is the chief Canadian milling center. The annual world wheat flour production totals about 135 million short tons (122 million metric tons).

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See also **BREAD**; **CORN (Milling)**; **GLUTEN**; **MACARONI**; **WHEAT (Wheat Flour)**.

**FLOUR BEETLE** is any of several small, reddish, flattened beetles that breed in flour, meal, and other grain products. They often spoil the food. Adult flour beetles are about  $\frac{1}{8}$  inch (1.5 millimeters) long. Flour beetles live all over the world, and all year long, in warm buildings.

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**Scientific Classification.** The flour beetle belongs to the family Tenebrionidae. Common species are *Tribolium confusum* and *T. castaneum*.

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**FLOW CHART.** See **COMPUTER (Planning a Program)**.